DEPARTMENT OF MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

~~RESTRICTED~~

RECORD 1973/178

PRESURVEY REPORT ON THE GEORGETOWN AND RED RIVER AIRBORNE MAGNETIC AND RADIOMETRIC SURVEY, QUEENSLAND, 1973

by

R.J. Taylor

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CONTENTS

SUMMARY

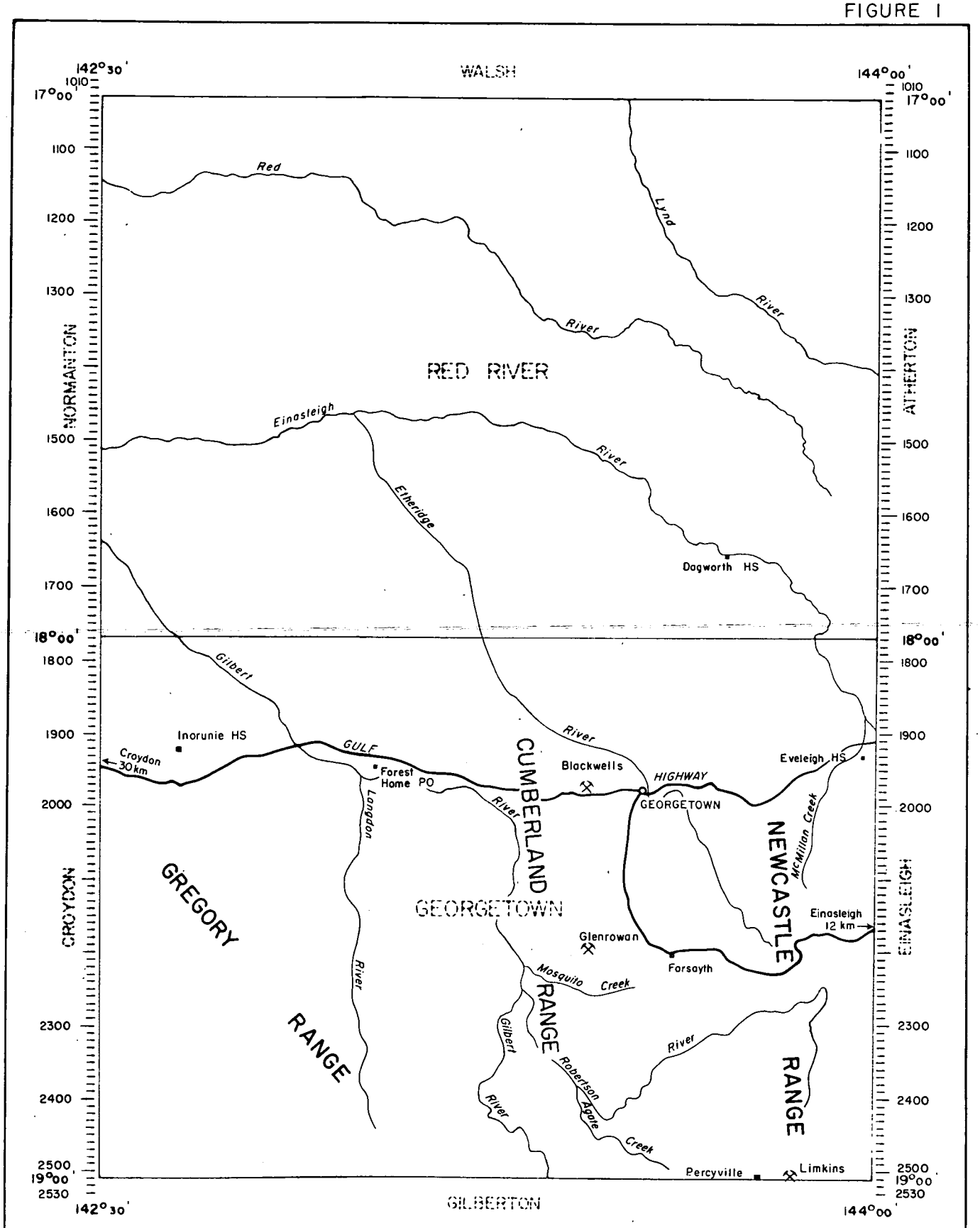
An airborne magnetic and radiometric survey of the RED RIVER and GEORGETOWN 1:250 000 Sheet areas, Queensland, has been programmed for late 1973.

The southern and eastern parts of the area, which are covered by the folded and faulted Precambrian-Palaeozoic rocks of the Georgetown Inlier, contrast with the northern and eastern parts of the area, which are covered by the apparently gently folded Mesozoic and Cainozoic rocks of the Carpentaria Basin. Within the Georgetown Inlier, gold reefs and copper, lead-silver, and uranium mineralization are associated with igneous and metamorphic rocks.

Previous regional gravity and airborne geophysical surveys over parts of the area have indicated several anomalies in the Georgetown Inlier: many are associated with concentrations of uranium in some of the granites, some can be attributed to changes in rock type, while others appear to reflect the continuation of surface structures into deep levels within the crust.

Results from the 1973 survey are expected to assist in the discovery of the provenance of uranium; promote the current knowledge of structures in the Georgetown Inlier and their contination beneath the Mesozoic and Cainozoic cover; and indicate any changes in the depositional environment during the Cainozoic.

FIGURE 1



AIRBORNE SURVEY, RED RIVER-GEORGETOWN, QLD 1973

LOCALITY MAP AND FLIGHT-LINE SYSTEM

KILOMETRES
10 0 10 20 30 40 50 60 70 80

MILES
10 0 10 20 30 40

To accompany Record No 1973/178

E54/81-64A

1. INTRODUCTION

An airborne magnetic and radiometric survey using Aero Commander VH-BMR will be conducted in the GEORGETOWN and RED RIVER 1:250 000 Sheet areas in late 1973. The two sheets are bounded by longitudes 142°30'E and 144°00'E and by latitudes 17°00'S and 19°00'S.

The objects of the survey are to aid detailed geological mapping and the study of the distribution and provenance of uranium mineralization.

The survey aircraft, equipped with proton magnetometer and 4-channel gamma-ray spectrometer, will be flown at a ground clearance of about 150 m along east-west lines at 1.5-km spacing.

Topography

The relief decreases towards the northwest of the survey area from about 300 m in the Newcastle and Gregory Ranges in GEORGETOWN to less than 5 m on the Holroyd Plain in RED RIVER. The Georgetown Uplands in the centre of GEORGETOWN contains numerous strike ridges with an average height of 30 m above the plain. The highest areas on the plains of RED RIVER are generally less than 30 m, though relief increases towards the southeast of the Sheet where the sedimentary rocks of the Carpentaria Basin lap on to the Georgetown Inlier.

2. GEOLOGY

The geology was compiled from White (1962, 1965), Needham (1971), BMR (1972), and Doutch, Smart, Grimes, Needham & Simpson (1972).

The major geological feature of the survey area is the Pre-Cambrian rocks of the Georgetown Inlier: about half of the GEORGETOWN Sheet and the southeast corner of the RED RIVER are covered by them. The remaining area of RED RIVER is covered by the Mesozoic and Cainozoic sediments of the Carpentaria Basin. The Precambrian rocks are intruded by the late Precambrian Forsayth Batholith and lesser amounts of Permian granites. Permian? acid volcanics are widespread. Sedimentary and metamorphic rocks are described first and then the igneous rocks.

Sedimentary and Metamorphic Rocks

The Precambrian sequence is divided into Archaean and Proterozoic rocks on the basis of contrasting grades of metamorphism.

The Archaean? Einasleigh Metamorphics consist predominantly of granitic gneiss, banded granulite, migmatite, and some schists and quartzite. These rocks are of the amphibolite to granulite facies of metamorphism, and have, in places, been retrograded by the intrusion of the Forsayth Batholith. The thickness of the Einasleigh Metamorphics is unknown because of tight folding, lack of marker beds, and sporadic outcrop.

The Proterozoic sediments are locally contact metamorphosed to hornfels, phyllite, or schist. The Etheridge Formation is a sequence of quartz siltstone, claystone, shale, and fine-grained quartz sandstone (locally silicified to quartzite), which crops out in a broad north-trending belt in

GEORGETOWN 100 km long and 45 km wide. The Etheridge Formation southwest of Forsayth is widely metamorphosed to schists - probably a result of the intrusion of the Forsayth Batholith. The formation is between 4500 to 6000 m thick. Dips are gentle to steep, and there is local strong folding.

The Langdon River Formation is exposed along the Langdon River in cores of synclines. It consists of shale, claystone, and quartz siltstone. Near Forest Home Homestead the formation is unconformably overlain by the sediments of the Carpentaria Basin. Elsewhere it is intruded by the Esmeralda Granite and overlain by the Croydon Volcanics, both Proterozoic. The formation is about 3000 m thick.

The metamorphic grade of the Etheridge Formation increases eastwards towards the Robertson River area. The Robertson River Metamorphics consist of interbanded schists and granulites of the staurolite-almandine subfacies of the almandine-amphibolite facies. These rocks appear to overlie the Etheridge Formation and the contact is structurally complex, being conformable in some places and not in others; it may be a thrust contact - hence the reason for the unusual stratigraphy. It is possible that the Robertson River Metamorphics are of Archaean? age, and have been thrust over the Proterozoic Etheridge Formation.

Small areas of thin Middle to Upper Palaeozoic sediments are exposed in faulted basins at Agate Creek, Cumberland Range, and Newcastle Range. These lie on thick sequences of acid volcanics.

The Mesozoic Inoruni Sandstone overlies the Croydon Volcanics. It forms well rounded hills of moderately clean quartzose sandstone with minor grits and shales, especially along the Georgetown-Croydon road. The formation is 300 m thick.

The quartzose sandstone, siltstone, shale, and conglomerate of the Eulo Queen Group are confined to the central part of GEORGETOWN.

The basal basin deposits of the central Carpentaria Basin are the quartzose sandstone, conglomerate, fine siltstone, and mudstone of the Gilbert River Formation, which also crops out in the inlier.

The Wallumbilla Formation occurs as isolated outcrops of massive sandy mudstone and clayey siltstone. In RED RIVER scattered limestone boulders lie on the rocks of the formation.

The Cainozoic stratigraphy is different on the two sheets, even though the rock types are similar. The Lynd Formation is exposed sporadically throughout the western portion of GEORGETOWN. It consists of clayey sandstones and conglomerates, which are in places lateritized and pisolitic. In the Langdon River area, spring deposits may reflect buried faults.

The clayey quartzose sandstones and sandy claystone of the Bulimba Formation and the Wyaaba Beds cover well over half of RED RIVER.

Igneous Rocks

Igneous rocks constitute half the rock units in the area, with granites and acid volcanics predominating. Lesser amounts of basic rocks are also exposed.

The Precambrian Cobbold Dolerite intrudes the metamorphic rocks of the Georgetown Inlier. The sills, dykes, and stocks are themselves intruded and locally metamorphosed to amphibolite by late Precambrian granites.

Three granites are recognized in the Forsayth Batholith: the Forsayth Granite; the Dumbano Granite, which intrudes the Forsayth Granite; and the Robin Hood Granite. These granites are similar - one-mica and two-mica granites, adamellites, and granodiorites.

The Permo-Carboniferous volcanic rocks are mainly rhyolites, ignimbrites, and rhyodacites, genetically related to high-level granites intruded in rift and cauldron subsidence fractures of the Precambrian inlier. The rhyolite and ignimbrite of the Newcastle Range Volcanics are intruded by the adamellite of the Elizabeth Creek Granite, whose contact with the Cumbana Rhyolite Porphyry is gradational and in places intrusive, which suggests that the porphyry is probably a hood of the granite. Other related granites and acid volcanics are the Prestwood Microgranite, which intrudes the Cumberland Range Volcanics, and the Esmeralda Granite, which intrudes the Croydon Volcanics. The Herbert River Granite is believed to have been formed from anatectic magma. Most of the granites have some associated mineralization which is discussed later.

The stratigraphic tables 1 and 2 show that other volcanics are exposed in the survey area, the most important being the Scardons Volcanics and the Galloway Volcanics, which crop out in RED RIVER. The olivine basalt of the Cainozoic McBride Basalt is extruded down the old Einasleigh River Valley.

Geological Structure

The Proterozoic sediments are folded into widely spaced anticlines and synclines, which pitch 25° to 35° to the west and northwest between the Gilbert and Langdon Rivers. Elsewhere folding is tight and isoclinal. The trend of the Proterozoic fold axes roughly conforms to the shape of the Archaean mass. The folding of the Archaean is unknown, but dips of foliation in the Archaean metamorphics are generally steep to vertical, suggesting isoclinal folding.

Folding appears to be gentle in the Mesozoic and Cainozoic sequences.

The Precambrian, Palaeozoic, and Mesozoic rocks have been faulted by strong vertical movements. The Delaney Fault extends north and south from Georgetown and for most of its length is intruded by rhyolite dykes. In places the fault coincides with the Archaean/Proterozoic boundary. Subsequent faulting parallel to this boundary caused cauldron subsidence resulting in a north-trending rift valley which was later filled with Newcastle Range Volcanics. The Robertson River near its confluence with the Gilbert River swings to follow a major northwest fault, the Robertson Fault, which has downthrown and tilted a block of Mesozoic sediments against Precambrian

sediments. The Robertson Structure is the northwest extension of this fault, passing through the southwest corner of RED RIVER into NORMANTON. Much block-faulting has occurred in the region of Agate Creek.

There are numerous cauldron subsidence areas represented by huge downfaulted blocks of Palaeozoic volcanics bounded by complex systems of linear faults and ring fractures, some of which were controlled by existing basement fractures. The central parts of large cauldrons resemble rift valleys (e.g. the rift filled with Newcastle Range Volcanics).

The main trend of faults follows the Robertson Structure, and movement may have occurred along some of them during the Cainozoic. However, most faults disappear below Mesozoic cover.

Mineralization

The Etheridge Goldfield contains about 150 gold reefs situated near the western edge of the Forsayth Granite; most are grouped around Georgetown and Forsayth. The reefs range from pure white quartz to nearly pure masses of galena, sphalerite, pyrite, and chalcopyrite. The gold is generally associated with the galena and pyrite. About 17 000 kg of gold have been obtained from the Etheridge Goldfield since 1877, with an average grade of 41.6 g/t.

Copper mineralization is generally located near the contact of the Forsayth Granite with the Einasleigh Metamorphics. About 7000 t of copper have been mined, and in 1942 60 t of ore was extracted from the McMillan Creek lodes, 24 km southwest of Eveleigh Homestead.

The lead-silver ore at Mosquito Creek was contained in quartz reefs injected into slate along bedding planes. The reefs averaged one metre wide and several tens of metres long. The ore at the Eveleigh silver-lead mine Eveleigh Homestead was exposed in minor fissures and as irregular impregnations in the Einasleigh Metamorphics. 4300 t of lead were mined between 1890 and 1957.

Uranium was discovered in 1954 at 'Limkin's Prospect' on Kurrajong Creek, 8 km east-northeast of Percyville. The prospect is located on an east-trending, quartz-filled fracture in kaolinized granite. Minor radioactivity is associated with lead at Blackwells mine, 12 km west of Georgetown. Uranium has also been discovered in the shield area of RED RIVER (Bain, pers. comm.).

Alluvial tantalite has been found at Glenrowan, about 18 km west of Forsayth, and alluvial and lode columbite has been found 15 km south of Georgetown. Both occurrences are associated with pegmatites.

3. PREVIOUS GEOPHYSICS

Three-quarters of the GEORGETOWN Sheet was covered by aeromagnetic surveys in 1954 and 1958 (Goodeve, 1955; BMR, 1961). Severe heading errors in the data resulted in a contour presentation which is difficult to interpret in terms of geology. However, four anomalies are apparent.

One appears to be associated with the Esmeralda Granite and the other three with the Newcastle Range Volcanics. The scintillometer anomalies obtained from the 1954 surveys are described by Goodeve (1955). Of the forty-one anomalies located by the airborne survey, seven were inspected by Walpole & Langron (1955), and 21 by Taylor (1956). The radioactivity of the area is very low and the anomalies are mostly due to weak localized concentrations of radioactivity or to topographic highs. Many of the anomalies are in granite; the non-radioactive alluvium and deep soil helps to accentuate the radioactivity of the granite. Two prospects in GEORGETOWN were inspected. Limkins contains torbernite, but the other, Blackwells, contains no uranium mineralization.

An airborne geophysical survey was carried out by Geophysical Resources Development Co. Ltd for Central Coast Exploration N.L. (O'Rourke, 1972) over leases crossing the border of GEORGETOWN and RED RIVER. Two strong total-count anomalies and numerous lesser ones were detected. One of the strong anomalies was over traces of uranium ochre in the south of RED RIVER, and the other coincided with a granodiorite mass which had a uranium content 2 to 3 times the average for that rock type. The other anomalies were attributed to the varieties in rock types. The magnetic data show clear correlation with rock type and structure. The Einasleigh Metamorphics contain widespread magnetic amphibolite masses, which probably account for many of the anomalies in the formation.

A regional gravity survey of eastern and central Australia was carried out in 1951-1952 by Marshall & Narain (1954). In the GEORGETOWN area their traverse followed the railway from Einasleigh to Forsayth and then the road from Forsayth to Croydon. Two major residual anomalies occur in the area between Einasleigh and Inorunie Homestead. One, of 35 milligals, is centred on Georgetown and the other, of 20 milligals, at Forest Home Homestead. A broad negative regional anomaly of -50 milligals between Einasleigh and Forsayth has the maximum value lying at the culmination of the Georgetown Inlier, the Forsayth Granite, the Newcastle Range Volcanics cauldron subsidence area, and a north-trending arm of the Elizabeth Creek Granite. The 35 milligal anomaly at Georgetown is only slightly higher in value than at Forsayth. This could well be related to the major fault zone which trends south from near Dagworth Homestead through Georgetown and Forsayth to Agate Creek. The anomaly shows that the fault continues to deeper levels in the crust. The 20 milligal anomaly at Forest Home Homestead may be similarly explained.

4. GEOCHEMICAL SURVEYS

Zimmerman & Howard (1962) took drainage samples in the Chillagoe/Herbert River Gorge area (in the neighbouring ATHERTON and EINASLEIGH sheets) and spectrographically analyzed them for Ni, Co, V, Mo, Zn, Pb, Ag, Cu, Sn, and Be. High values for Pb and low values for Ni, Co, and V indicate proximity

of granite, though no attempt was made to distinguish between granites. High Sn values were recorded in the Elizabeth Creek Granite, and high Zn, Ag, Cu, V, and Mo values in the Herbert River Granite.

5. EXPECTED RESULTS

The results of the survey are expected to assist generally the geological mapping of the region and in particular may assist the investigation of the specific geological problems and areas of interest listed below:

1. A strong total-count radiometric anomaly occurs in the rocks of the Georgetown Inlier in central-southern RED RIVER. It will be of interest to find out if other such anomalies occur in similar rocks elsewhere.

2. It may be possible to delineate different types of granites according to their magnetic and radiometric properties. In particular, radioactivity may assist in discovering the provenance of the uranium mineralization. For instance, the Forsayth Granite is known to be radioactive in part and may be the source of the uranium.

3. The magnetic data may be of use in the further study of the fault-bounded structures of the Carpentaria Basin part of RED RIVER, and of the cauldron subsidence areas of the inlier.

4. The Robertson River Metamorphics are probably Archaean rocks thrust over the Proterozoic Etheridge Formation; the magnetic data may help to solve this problem.

5. The Robertson Structure may prove to be the northwesterly extension of the Robertson Fault of the Agate Creek area; the relative movement of this and other major faults may be determined.

6. Most faults disappear below Mesozoic cover; the magnetic data may show the extent of the faults below this cover.

7. During the deposition of the Gilbert River Formation the environment may have changed from marine to terrestrial. This change may be apparent in the magnetic and radioactivity properties of the rocks.

8. Branch (1966) suggests that the collapse of a roof above a ring intrusion of Esmeralda Granite formed the ring-fault-bounded basin in which the Inoruni Sandstone crops out; the survey results may confirm this suggestion.

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TABLE 1

STRATIGRAPHY OF THE RED RIVER 1:250 000 SHEET AREA

CAINOZOIC	RECENT		Quartzose sand, silt, alluvium, and clay. Some black soil development
	PLIOCENE? TO RECENT	WYAABA BEDS	Quartzose sand and gravel, colluvial and outwash deposits. Clayey sandstone and grit with some pebbles. Basalt flows
		McBRIDE BASALT	Olivine basalt
	TERTIARY?		Ferruginized lithified soil and colluvium (duricrust)
MESOZOIC	UPPER CRETACEOUS OR TERTIARY?	BULIMBA FORMATION	Poorly sorted clayey quartzose sandstone and granule conglomerate. Pebbles, interbedded sandy claystone
	LOWER CRETACEOUS	WALLUMBILLA FORMATION	Mudstone, siltstone, minor limestone commonly nodular. Glauconitic sandstone beds and lenses in lower part
	UPPER JURASSIC TO LOWER CRETACEOUS	GILBERT RIVER FORMATION	Clayey sandstone, siltstone, some shale, quartzose sandstone, and minor conglomerate. Pebbly in parts. Fossiliferous
PALAEOZOIC	UPPER PALAEOZOIC		Dolerite, rhyolite, diorite, and granite
	UPPER CARBONIFEROUS TO LOWER PERMIAN	ELIZABETH CR GRANITE	Pink microadamellite
		HERBERT R. GRANITE	Grey porphyritic adamellite and granodiorite
	UPPER	GALLOWAY VOLCANICS	Rhyolite, tuff, ignimbrite, and sediments
	CARBONIFEROUS	SCARDONS VOLCANICS	Rhyodacite lavas and welded tuffs
	DEVONIAN	NEWCASTLE RANGE VOLCANICS	Rhyolite, ignimbrite, pyroclasts, and sediments
PRECAMBRIAN	PROTEROZOIC	CROYDON VOLCANICS	Ignimbrite, rhyolite, and rhyolite-porphyry
		FORSAYTH GRANITE	Grey porphyritic biotite adamellite and granodiorite
		COBBOLD DOLERITE	Dolerite and amphibolite
		ETHERIDGE FORMATION	Shale, siltstone, sandstone, and chert
	ARCHAEAN?	EINASLEIGH METAMORPHICS	Granulite, gneiss, migmatite, amphibolite schist, and quartzite

TABLE 2.

STRATIGRAPHY OF THE GEORGETOWN 1:250 000 SHEET AREA

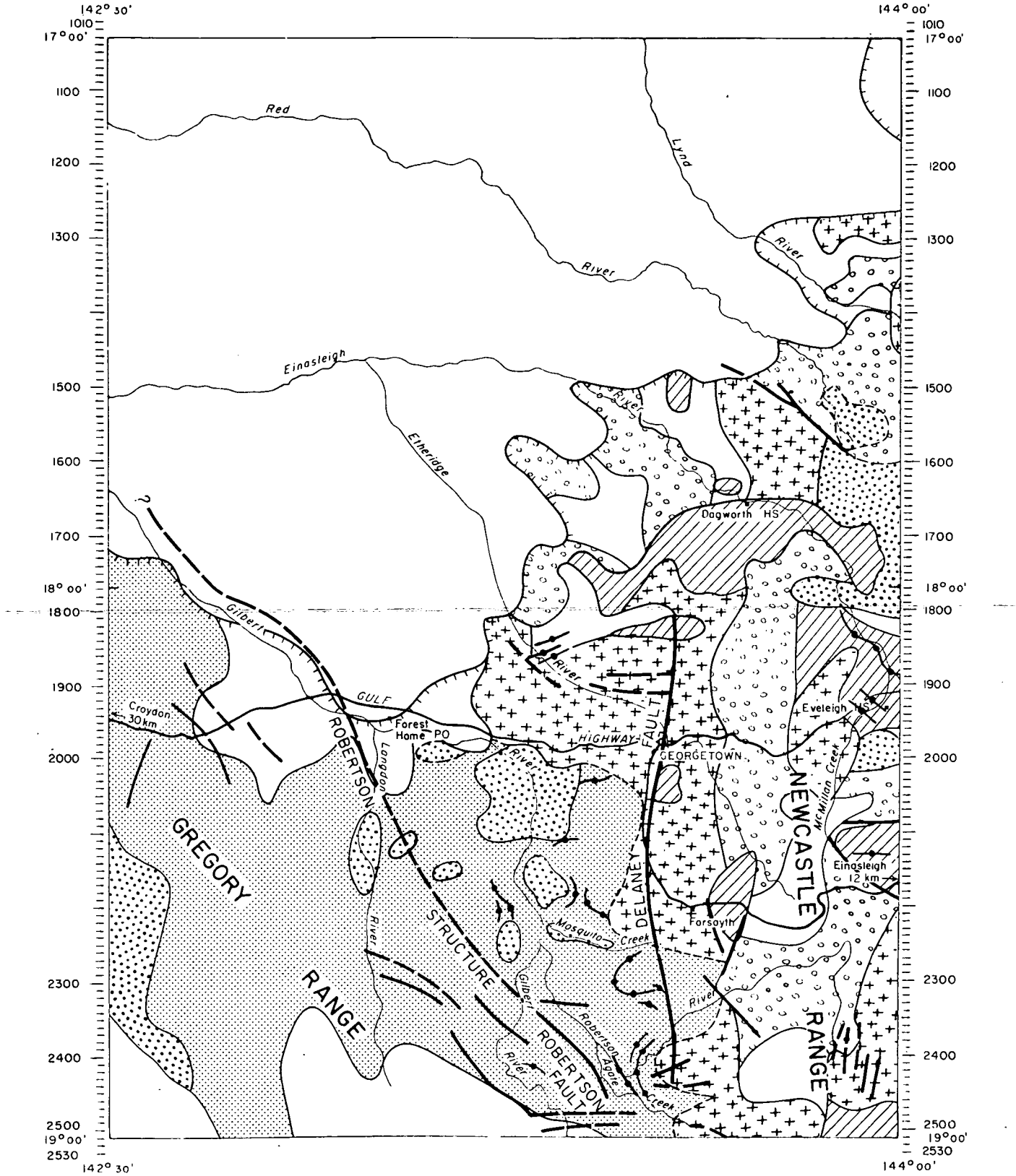
CAINOZOIC	QUATERNARY		Stream sediments and flood plain alluvium: sand, silt, and clay
			Colluvium and outwash deposits: quartzose sand and gravel
	PLIOCENE TO RECENT	WYAABA BEDS	Outwash plain deposits: sand, pebbles, clayey sandstone
		McBRIDE BASALT	Olivine basalt
	TERTIARY?		Nodular ferricrete ('laterite') and ferruginized lithified soil and colluvium (duricrust)
MESOZOIC	UPPER CRETACEOUS OR TERTIARY?	BULIMBA FORMATION	Poorly sorted clayey quartzose sandstone and granule conglomerate, pebbly in places. Sandy claystone
	LOWER CRETACEOUS	WALLUMBILLA FORMATION	Mudstone and quartz-poor sandstone, and minor glauconitic sandstone
	UPPER JURASSIC TO LOWER CRETACEOUS	GILBERT RIVER FORMATION	Clayey sandstone, siltstone, shale, quartzose sandstone, and minor conglomerate; fossiliferous at top
	MIDDLE? TO UPPER JURASSIC	EULO QUEEN FORMATION	Quartzose clayey sandstone, quartzose sandstone, siltstone, minor shale, and some conglomerate. Sandstone commonly pebbly
	?	INORUNI SANDSTONE	Quartz sandstone, some grit and shale
PALAEOZOIC	UPPER PALAEOZOIC		Rhyolite, and quartz porphyry
	LOWER TO MIDDLE PERMIAN	AGATE CREEK VOLCANICS	Ignimbrite, rhyolite basalt, and minor shale and mudstone
	UPPER CARBONIFEROUS TO LOWER PERMIAN	PRESTWOOD MICROGRANITE	Grey porphyritic biotite microgranite
		ELIZABETH CR. GRANITE	Pink leucocratic massive adamellite
		CUMBANA RHYOLITE PORPHYRY	Pink rhyolite porphyry
	UPPER CARBONIFEROUS	CUMBERLAND RANGE VOLCANICS	Rhyolite, tuff, ignimbrite, minor arkosic sandstone, and shale
		GALLOWAY VOLCANICS	Rhyolite, ignimbrite, minor quartzose sandstone, and conglomerate
	DEVONIAN?	NEWCASTLE RANGE	Rhyolite, ignimbrite, pyroclastics, and arkosic sandstone and conglomerate
	U. SILURIAN? TO LOWER DEVONIAN	DUMBANO GRANITE	Grey biotite granite

.../2

TABLE 2. (Cont.)

PRECAMBRIAN	PROTEROZOIC	FORSAYTH GRANITE	Grey porphyritic biotite granite
		ROBIN HOOD GRANITE	Pink-grey hornblende-biotite granite
		ESMERALDA GRANITE	Grey biotite adamellite and granodiorite
		CROYDON VOLCANICS	Ignimbrite, rhyolite, and rhyolite-porphyry
		COBBOLD DOLERITE	Dolerite and amphibolite
		LANGDON RIVER FORMATION	Shale, siltstone, and quartz-greywacke
		ETHERIDGE FORMATION	Shale, siltstone, sandstone, and chert; carbonaceous siltstone in Stockyard Creek Member
		ROBERTSON RIVER METAMORPHICS	Garnet-staurolite-mica schist, quartz-muscovite schist, and quartzite lenses
	ARCHAEAN?	EINASLEIGH METAMORPHICS	Gneiss, migmatite, schist, and amphibolite

FIGURE 2



GEOLOGICAL LEGEND

- Mesozoic and Cainozoic sediments
- Palaeozoic volcanics and sediments
- Palaeozoic granites (Esmerald, Prestwood and Elizabeth Creek Granites)
- Proterozoic metamorphics, sediments and volcanics
- Proterozoic granites (Forsayth and Robin Hood Granites)
- Archaean metamorphics
- Fault
- Possible fault
- Dyke or sill
- Georgetown Inlier boundary

AIRBORNE SURVEY, RED RIVER-GEORGETOWN, QLD 1973

GENERAL GEOLOGY

KILOMETRES
10 0 10 20 30 40 50 60 70 80

10 0 10 20 30 40
MILES

To accompany Record No. 1973/178

E54/B1-66A